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NEWSLETTER

FALL 1996

GPS Plot Layout

Doug Mackay, Project Engineer, Edmonton

The Global Position System, or GPS, is a constellation of 24 satellites operated by the U.S. Department of Defense. With the proper receiver, radio signals transmitted from these satellites can enable the user to pinpoint their location to within 100 metres. The military introduces intentional errors into the signal to reduce the accuracy of civilian users, but using a second receiver over a known location can decrease the error to sub-metre level. A stationary receiver, called a base, is set up over a known location (such as a survey benchmark). The moving unit, or rover, is mounted on a truck, ATV, tractor, or even a backpack (as shown) to make it truly portable. A pair of FM radio modems is used as the real-time data link between the base and the rover. This is called differential GPS or DGPS since the base unit is correcting the position to the known location and applying the same difference to the rover unit. Engineering Services is currently using NovAtel AG-20 GPS receivers to achieve an accuracy of 20 cm or better.

Traditional methods for large plot layouts are now outdated thanks to GPS. In August, several 40-acre plots were laid out for tractor testing in the Lethbridge area. After choosing a starting point, a distance and bearing is used to calculate the next point in the plot. This location is entered into a handheld computer and can be navigated to. Stakes are placed along a line between the two points using the cross-track error to stay on course. Using this method, plots can be laid out by simply driving around the perimeter of the area one wants to mark. It can also be applied to grid soil sampling or to parallel track applications such as spraying or tillage to prevent costly misses and overlaps.

Alberta
AGRICULTURE, FOOD AND
RURAL DEVELOPMENT
Engineering Services

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The purpose of this newsletter is to advise of activities and projects being conducted by Alberta Agriculture, Food and Rural Development's Engineering Services and Regional Agricultural Engineering staff. For further information on these projects and other engineering related activities contact:

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Airborne Spray Drift Results

Brian Storozynsky, Field Technologist, AFMRC, Lethbridge

The Alberta Farm Machinery Research Centre (AFMRC) and Regina Research Station of Agriculture and Agri-Foods Canada conducted field trials in 1994 and 1995 to measure airborne spray drift from Flexi-Coil's windscreen and Bourgault's Clearview air curtain. Both sprayers tested with the extended range, 80°, 015 nozzles, i.e., XR80015 and ER80015. In addition, drift was measured from a high clearance sprayer equipped with XR, TT and DG nozzles. An air-assist system mounted on the high clearance sprayer was also tested.

The XR, TT and DG nozzle types stand for extended range, wide angle turbo TeeJet and drift guard flat fan nozzles, respectively. Wide angle turbo TeeJet nozzles were introduced in the spring of 1995. Extended range nozzles have been used for several years. Small spray droplets, good coverage at low pressures and heights, and compatibility with automatic rate controllers make the extended range nozzles popular among applicators. However, some inexperienced applicators ignored fundamental spraying practices that resulted in increased amounts of spray drift using extended range nozzles. Recent spray drift lawsuits and complaints by neighbouring farmers have increased, prompting the spray drift trials.

The table shows the amount of airborne spray drift as a percentage of the chemical sprayed. Flexi-Coil's windscreen reduced airborne spray drift by 80% in 30 km/h crosswinds. Bourgault's Clearview air curtain reduced airborne spray drift by 50% in 30 km/h crosswinds. Spray drift averaged 10% without the shrouds, 6% with the Clearview air curtain and 2% with the windscreen.

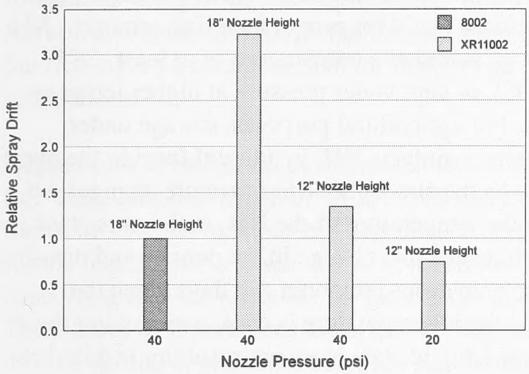
In 20 km/h crosswinds, airborne spray drift was 15, 8 and 8% from the XR11002, DG11002 and TT11002 nozzles respectively. Spray drift from the extended range XR11002 nozzles was highest. This was expected since XR nozzles produce a higher percentage of spray droplets below 100μm than DG or TT nozzles at 275 kPa spraying pressure. Drift was similar for DG11002 and TT11002 nozzles. The TT nozzles work best in windy spraying conditions for applicators using automatic rate controllers and sprayers with unsupported booms that frequently strike the ground. The air system increased spray drift by 5%. Spray drift increased from 15 to 20% in a 20 km/h crosswind. Applicators using air-assist systems strictly for controlling spray drift are cautioned. The air system will be retested at a different setup to increase its potential as a spray drift reduction device.

Airborne spray drift from standard 8002 flat fan nozzles are shown for a reference point. Results

Sprayer Operating Conditions and Airborne Spray Drift Results (% of chemical)

Sprayer Type	Nozzles	Spray Height (mm)	Spray Rate (L/ha)	Spraying Speed (km/h)	% Spray Drift	
					20 km/h wind	30 km/h wind
Conventional	DG11002	450	100	8	2.1	N/A
Conventional	8002	450	100	8	2.7	3.4
Conventional	8001	450	50	8	7.7	12.4
Flexi-Coil Windscreen	ER80-015	450	50	12	1.3	1.9
Bourgault Air Curtain	XR80015	450	50	12	4.2	6.1
Conventional (Avg)	XR/ER 015	450	50	12	6.1	10.3
High Clearance	DG11002	600	30	30	7.5	12.7
High Clearance	TT11002	700	30	30	7.7	12.4
High Clearance	XR11002	600	30	30	14.8	23.4
High Clearance (air assist)	XR11002	600	30	30	19.6	29.2
Spray Air	Airfoil	450	35	8	10.3	14.3

show that operating high clearance sprayers at a high speed and spray height create more spray drift. For example, spray drift from the DG11002 nozzles was 2.1% when used the conventional way and 7.5% when used on the high clearance sprayer. As the wind increases, custom applicators using extended range nozzles, especially 110° nozzles, should reduce spraying speed. When equipped with automatic rate controllers, speed should be reduced until the nozzle pressure falls below 150 kPa. As shown in the graph, spray drift reduces to acceptable levels at low nozzle pressures and heights. However, reducing spraying speed reduces work rates. At $4.00 per acre, some operators find this an unacceptable alternative.



Effect of Reducing Spray Pressure & Height
(Extended Range XR11002)

ILO Manure Management Project in Southern Alberta

Brian West, Waste Management Specialist, Red Deer

A major initiative to increase awareness and effect changes to nutrient management practices is being developed by the livestock industry in Southern Alberta. Over the past few years, research has shown the need to balance fertilizer application rates with crop requirements. With the intensity of livestock production in the County of Lethbridge, concern is increasing about possible groundwater impacts if application rates are not brought into line with crop production needs. This project is being directed by the livestock industry including beef, pork, dairy and poultry. Engineering Services is a partner, along with Alberta Environmental Protection, Chinook Health Unit, County of Lethbridge, Prairie Farm Rehabilitation Administration, the Agronomy Unit and the Irrigation Branch of Alberta Agriculture, Food and Rural Development, and other agencies. Our role will focus on the development and delivery of technical information needed for this program.

Water Quality Surveying

Darcy Fitzgerald, Resource Management Agrologist, Edmonton

Complex issues related to dugout water quality were the most striking results from the CAESA Farmstead Water Quality Survey Pilot Project conducted in 1994. Many of the 192 farms surveyed used dugout water for drinking, household use and livestock watering. Most dugout supplies had little or no treatment before the water was consumed. Results show that 53% of these dugout supplies failed to meet the microbiological guidelines set by the Canadian Drinking Water Guidelines and 48% had trace levels of herbicides detected. Local Health Units immediately notified landowners with water supplies that did not meet human health criteria and reminded local communities that all surface water supplies used for consumption should be treated.

The pilot project's one-time sample only illustrated a quick "snapshot" and does not reflect seasonal changes to dugout water quality. Therefore, the new Northern Alberta Dugout Water Quality Survey was initiated in February of 1996 to create a complete picture. This survey focuses on the Peace River Region, as a large portion of the region's farming community rely on dugouts for daily domestic and livestock water. Fourteen dugouts are being sampled every two months, over a two-year period. Dugout owners will also record any water quality problems, treatment methods applied, and any health problems that might be related to water quality. Many federal, provincial and municipal agencies are participating to increase the understanding of problems faced by dugout owners and raise an awareness of practices necessary for safe dugout water supplies.

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The Farm Water Quality Survey is presently wrapping up the final sample collection year. Over the next month, approximately 400 farm water well sites will be sampled. The purpose of this survey is to benchmark the sustainability of on-farm well water supplies in Alberta.

Using Models to Predict Soil Disturbance

Vince Murray, Project Engineer, AFMRC, Lethbridge

The "Weeds versus Soil Disturbance" project has lead AFMRC research staff to try to predict the area of soil disturbed by openers. The McKyes-Ali model was chosen because of its ability to make reasonable predictions without the use of complex finite element methods. This model requires knowledge of the internal friction angle and cohesion of the soil at each site. Such information can be determined by doing a series of direct shear tests on soil samples. The necessary equipment to conduct tests was available at the University of Alberta's Civil Engineering Department.

During spring seeding, soil samples were collected at each site then taken to the University of Alberta. Data collected from the direct shear tests was used to calculate the internal friction angle and cohesion for each site. This information was then plugged into the McKyes-Ali model. Initial comparisons of predicted values to measured data were inconclusive. The McKyes-Ali model was designed for simple tillage tools and not the more complex shapes of openers like the Flexi-Coil LS Paired Row Double Shoot Knife Opener used in this experiment. Data collected in the coming years will decide if the model can be used to predict the effect more complex shaped tillage tools have on soil.

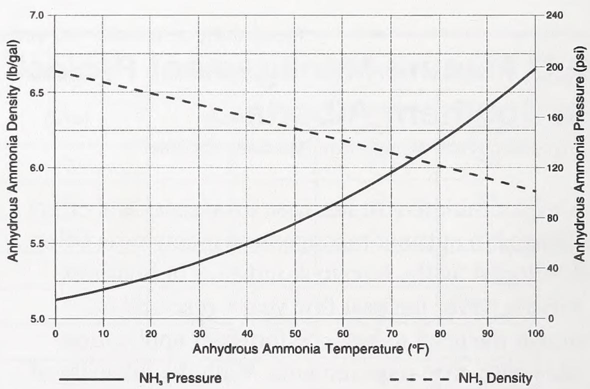
Understanding Anhydrous Ammonia

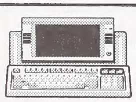
Gregory Magyar, Field Technologist, AFMRC, Lethbridge

After recently evaluating the four anhydrous ammonia (NH_3) controllers (Report #723) it became evident producers do not fully understand the characteristics of anhydrous ammonia. A common question asked was:

"Is there something wrong with my controller? Compared to warm days, I can complete more acres with a nurse tank when the temperature is cooler."

A simple way to answer this question is to look at the state of anhydrous ammonia in the nurse tank. To remain liquid for proper metering accuracy, NH_3 must be stored at a temperature of at least -28°F (-33°C), or kept under pressure at higher temperatures. For agricultural purposes, storage under pressure maintains NH_3 in a liquid form in the nurse tank. As the atmospheric temperature changes, so does the temperature of the NH_3 in the nurse tank, which results in a change in the density and pressure of the anhydrous ammonia. On days when the atmospheric temperature is cool, maintaining the NH_3 in a liquid state is easier, resulting in a higher content of liquid ammonia in the nurse tank compared with days when the temperature is warm.





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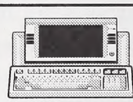


Typically, NH_3 weighs 6.32 lbs/gal (0.63 kg/L) at 41° F (5° C) and 61 psi (42 kPa). An increase in temperature to 59° F (15° C) decreases the NH_3 density to 6.17 lbs/gal (0.62 kg/L), while a decrease in temperature to 23° F (-5° C) increases the NH_3 density to 6.46 lbs/gal (0.65 kg/L). Using the appropriate constant to determine the available NH_3 in the nurse tank will help the producer calculate the number of acres the given nurse tank will complete.

Foundations for Hopper Bins

Dennis Darby, Farm Structures Engineer, Lethbridge

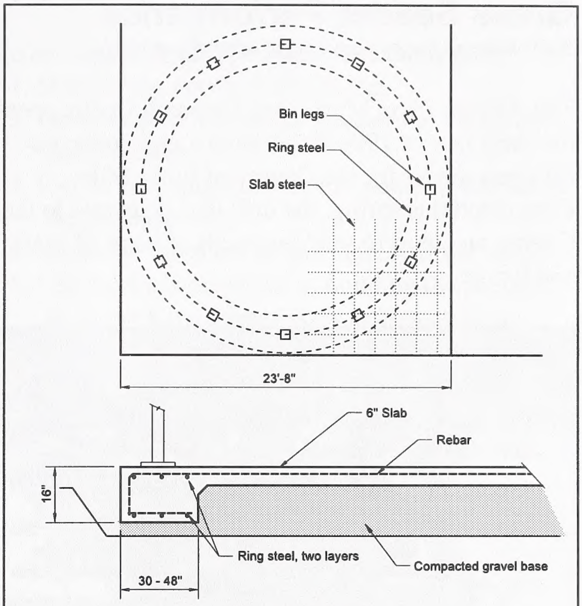
Every year we get reports of hopper bin failures, many of which are attributed to poor or improper foundation design. Alberta Agriculture, Food and Rural Development, through the Canada Plan Service, have an excellent plan for hopper bin foundations.

Hopper bins exert heavy, concentrated loads. When full, these bins can weigh up to 150 tons and exert forces of 15 to 20 tons per leg. The main criterion for the foundation is to see that both it and the supporting area are adequate for these large loads. Three types of foundations are effective; each has its own special application. They are slab foundations, ring footings, piles of reinforced concrete or steel.

Slab foundations are easy to construct. Reinforcing and a thickened edge is all that is required. Heavier loads should be supported on a reinforced ring footing, with a slab poured over (if desired). Doughnut-shaped ring footings require moderate to heavy circular reinforcing.

Concrete piles under each leg are a good alternative, provided the pile is large enough for the load. For a 15-ton load, a typical concrete pile should be 18 inches in diameter by 20 to 24 feet deep. This is a large pile! Small 10 inch post auger holes filled with concrete are nowhere near adequate.

A new development is a screwed-in-place steel support. First developed for oil industry sites, these can be described as a giant corkscrew, 12 to 16 inches in diameter, and must be installed with heavy industrial drilling equipment. The same type of equipment is required for a large concrete pile. Steel anchor costs are similar to concrete, but have the added advantage of being relocatable.



Typical Ring Footing

Research on Precision Farming Moves to Potatoes

Murray Green, Farm Machinery Specialist, Airdrie

Engineers have joined a team to apply Global Positioning and yield monitors to potato harvesting. The fundamentals of this project are similar to a precision farming project on grains, which is completing its fourth and final year. This project is being conducted on farms in the Hays and Grassy Lake areas and is expected to last four years. A base monitor station is providing differential position correction to the rover GPS receiver on a potato combine. A yield monitor designed by HarvestMaster, uses load cells under the potato conveying chain to measure the quantity of potatoes dug from that point in the field. Data obtained will be analysed and displayed as a map showing how

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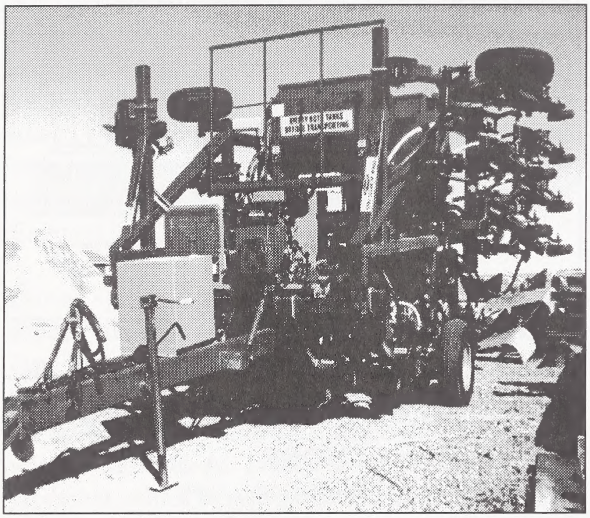
the yield varies over the field landscape. With the aid of aerial photography, soil moisture records, salinity mapping (also GPS generated), and potato quality testing, researchers and farmers can make better management decisions.

Grass Seeder Performance

Blaine Metzger, Project Technologist, AFMRC, Lethbridge

The Alberta Farm Machinery Research Centre spent the early part of 1996 developing a pneumatic no-till grass seeder for the County of Forty Mile. Completed this spring, the drill was delivered to the County and used to seed hundreds of acres of grass and forage.



The grass seeder received good feedback from most users. Excellent grass and forage establishment was achieved if the seedbed was presprayed for total weed control. Seeding into unsprayed seedbeds allowed too much competition for moisture, resulting in poor emergence. The grass seeder's openers, (Flexi-Coil Double Shoot Angle Disk Openers) had excellent soil penetration and trash clearance in all types of conditions, with very low soil disturbance. The openers had four seed and fertilizer placement and separation settings, and worked well at each setting. Seed emergence was the same or better than other grass seeders used by the County.

Problems encountered with the grass seeder were mainly mechanical. Many bearings on the openers were worn out by the end of the spring seeding season. The Valmar fan was not large enough to blow high amounts of fertilizer and seed through the distribution system. Some users did not understand how to set the opener's seeding depth properly. The County and Flexi-Coil believe improper adjustments on the openers caused them to have higher than normal wear, less penetration, less trash clearance and uneven seeding depths.

The County of Forty Mile plans to continue testing and evaluating the grass seeder during the fall. Flexi-Coil is currently looking at ways to improve the durability of their openers. Recommendations made by the County and Flexi-Coil on setting and operating the drill will be given to each user to improve grass or forage crop establishment and reduce mechanical failure in the future.

Getting the Most Out of Your Water Pressure System

Ken Williamson, Agricultural Engineering Technologist, Red Deer

I once heard the saying *"It's not the mountains that wear you down on life's journey, but the grain of sand in your shoe"*. Every farm has more than enough grains of sand but please forgive me if I add another to the pile.

Your well pump is a small but necessary part of your operation. It quietly works away, without anyone paying any attention to it, until it suddenly dies on Christmas Eve when its -40° C. The biggest enemy of a pump, or any electric motor, is frequent on-off cycling. The device that prevents the pump from constantly cycling is the simplest mechanical device on your farm - the pressure tank. A pressure tank uses trapped compressed air to deliver water to your water distribution system when the pump is off. When the pressure drops below a preset level, the pump turns on and repressurizes the tank. It does this by refilling it with water and recompressing the trapped air. The bigger the tank and the more air that is trapped in it, the less fre-

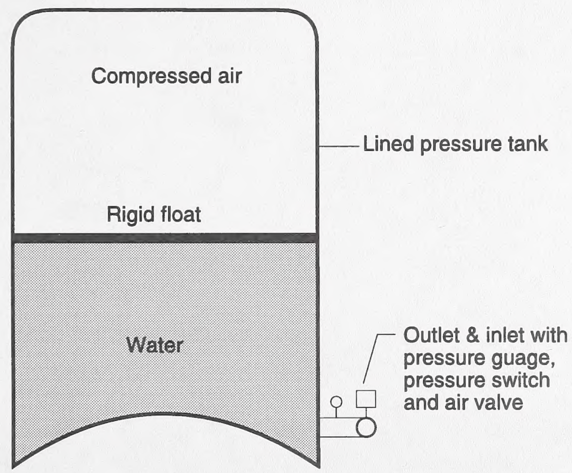
quently the pump must come on. For example, a 20 gallon pressure tank will hold 7.4 gallons of water between pump cycles. A 40 gallon tank will provide 14 gallons of water between cycles.

If the compressed air and water come into contact with each other, the air will slowly become absorbed in the water. This reduces the volume of air trapped in the tank. Eventually, there will be so little air in the tank that the pump has to come on every time a cup of water is used. This is called a "waterlogged pressure tank" and is very hard on the pump.

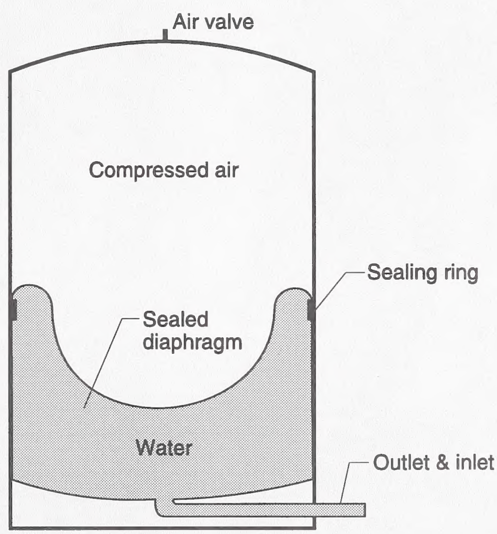
The majority of farms use a precharged float type pressure tank (as shown below) which contains a rigid float to help combat this problem. This rigid float covers the water surface, separating it from the air, thus decreasing the rate of air absorption. This slows down the air absorption process, but does not stop it. This type of pressure tank usually needs to be recharged with air every six months or so to maintain optimum performance.

A sealed diaphragm pressure tank uses a sealed bladder or diaphragm to prevent waterlogging. This type of tank is the easiest to maintain as it should never have to be recharged unless the air valve leaks or the bladder breaks. Some older pressure systems are designed to add and release air automatically using air volume controls.

To recharge a float type pressure tank properly:
1. Shut off the power to the pump.
2. Open a tap to release the pressure in the distribution system.
3. Use an air compressor or tire pump to add air to the pressure tank.
4. When the tap starts to spurt air, shut the tap off.
5. Use the air compressor to build up the pressure in the tank until there is about 5 pounds per square inch (psi) less pressure in the tank than the cut in pressure of the pump. If your pressure switch is set to turn the pump on at 20 psi and off at 40 psi, add 15 psi of air to the tank.
6. Turn the power back on.



Precharged float type pressure tank



Sealed diaphragm pressure tank

Thank You! to all who responded to the questionnaire that ran in our Spring '96 issue. Your comments and suggestions were greatly appreciated.

Engineering for Beef Production

Robert Borg, Agricultural Engineer, Red Deer

Last fall, a major engineering development project was to write a facilities section for the *Cow-Calf Home Study Manual (Beef Herd Management)*. Topics included were housing, calving systems (including calving barns), environmental management for overwintering sites, pasture water quality and supply, fencing, and cattle handling. Several engineers contributed to the project.

This year, a feedlot manual is being developed. Material on facility design will include pen design, feedlot layouts and types, cattle handling, feeding and watering systems, and site selection. Emphasis will be placed on how to design a feedlot for good flow of cattle, feed, and waste. A research project near Vermilion (Brian Kennedy and others) funded by CAESA (Canada-Alberta Environmentally Sustainable Agriculture Agreement) is confirming models of feedlot hydrology - how to design for good pen drainage, feedlot drainage, and storage runoff.

The diagram below illustrates a feedlot layout that will fit on a sloping site. All drainage and traffic are across the contour. Cattle handling and feed preparation areas are located at opposite ends so that cattle flow and vehicle traffic do not cross paths. Runoff flows to drains down slope and outside the pens to maximize pen area. Cattle handling alleys are separate from the drains and feeding alleys.